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Application No. 10/693,961
Amendment dated January 10, 2006
Reply to Office Action of October 11, 2005

Amendments To The Specification:

Please replace paragraph [0003] with the following amended paragraph:

[0003] As shown in Fig. 1a, the opposed ends of each conventional shroud segment 5 are straight cut to provide parallel mating faces 7 between adjacent segments 5. At room temperature each pair of adjacent shroud segments 5 defines a gap 7. In operation, the shroud segments 5 do not have uniform temperature distribution (the upstream side of the shroud segments 5 is typically exposed to higher temperature than the downstream side thereof). As shown in Fig. 1b, this causes non-uniform thermal expansion and thus non-optimized intersegment gaps in operating conditions. The shroud segments 5 will be hotter upstream and cooler downstream of the gas path, which makes the thermal expansion uneven and creates a larger gap on the downstream side where air can escape the cavity defined about the shroud segments 5. As shown in Fig. 1b, the high thermal expansion will reduce the gap on the upstream side of the shroud segments 5, whereas the low thermal expansion will leave a larger gap on the downstream side of the segments 5.

Please replace paragraph [00011] with the following amended paragraph:

[00011] Figs. 1a and 1b are enlarged schematic side views of a number of shroud segments forming part of an annular shroud adapted to surround a stage of turbine blade of a gas turbine engine;

Please add the following new paragraph after paragraph [00015]:

Fig. 6 is a simplified enlarged side view of the shroud segments illustrating the bowed profile thereof when the engine is not operated.

Please replace paragraph [00018] with the following amended paragraph:

[00018] Referring now to Fig. 3, the turbine shroud 26 is disposed radially outward of the plurality of rotor blades 24. The turbine shroud 26 includes a plurality of circumferentially adjacent segments 28 (only one of which is shown in Fig. 3), each pair of adjacent segments 28 providing an expansion joint. More particularly, each pair of adjacent segments 28 defines an intersegment gap 29 (see Figs. 4a and 4b and Fig. 6) to provide for the radial expansion and contraction of the turbine shroud 26 during normal engine operation. The segments 28

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form an annular ring having a hot gas flow surface 30 (i.e. the radially inner surface of the segments) in radial proximity to the radially outer tips of the plurality of rotor blades 24 and a radially outer surface 32 against which cooling air is directed to cool the shroud 26. Each segment 28 has axially spaced-apart upstream and downstream sides 34 and 36.

Please replace paragraph [00019] with the following amended paragraph:

[00019] The hot air which flows generally axially along the radially inner surface 30 of the shroud 36_26, as depicted by arrows 38, cools down as it travels from the upstream side 34 to the downstream side 36 of the shroud 26, thereby causing the upstream side 34 of the shroud segments 28 to expand more than the downstream end 36 thereof, as the latter is exposed to lower temperatures. This is represented by arrows 40 and 42 in Fig. 4b, arrow 40 representing the thermal growth of the upstream side 34 of the shroud segments 28, whereas arrow 42 represents the thermal growth of the downstream side 36 of the segments 28.

Please replace paragraph [00020] with the following amended paragraph:

[00020] To compensate for said non-uniform expansion of the segments 28 and thus provides for uniform intersegment gaps during engine operation, it is herein proposed, as shown in Fig. 4a, to machine one end of the shroud segments 28 at an angle so that the intersegment gaps 29 close uniformly in operating conditions, thereby leaving a smaller gap and, thus, reducing leakage that would otherwise negatively affect the performances of the engine 10.

Please replace paragraph [00021] with the following amended paragraph:

[00021] As shown in Fig. 4a, one end 44 of each shroud segment 28 is cut slantwise at an angle determined by the thermal expansion gradient observed between the upstream side 34 and downstream side 36 of the shroud segments 28. This provides for non-parallel confronting faces 46 at room temperature so that, when the engine 10 is not operated, each intersegment gap 29 is ~~more important~~ greater on the upstream side 34 than on the downstream side 36 of the shroud 26. However, during engine operation, the upstream side 34 expands more than the downstream side 36, thereby bringing the confronting faces 46 in parallel to one another while the gap 29 is being closed as a result of the expansion of the

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shroud segments 28. The gaps 29 need not be sized to obtain exactly parallel confronting faces 46 during engine operating conditions, but rather any desired margin may be left to account for preference in design, etc.

Please replace paragraph [00022] with the following amended paragraph:

[00022] The angled cut at the end 44 (Fig. 4a) thus allows to compensate for the axially uneven thermal expansion of the shroud segments 28 and thereby caused the intersegment gaps 29 to close uniformly in operating conditions.

Please replace paragraph [00025] with the following amended paragraph:

[00025] It is also understood that the present invention can be applied to any temperature distribution, as opposed to the above-discussed example where the temperature distribution is linear from one end of the segments to the other. For instance, for a parabolic temperature distribution during normal cruise engine operation, one end of the segments could be machined with a bowed profile instead of a straight line in order to obtain the same result, i.e. an intersegment gap that closes uniformly at operating temperatures (see Figure 6). With this concept, all temperature profiles can be captured, simple or complex.

Please replace paragraph [00028] with the following amended paragraph:

[00028] The embodiments of the invention described above are intended to be exemplary. Those skilled in the art will therefore appreciate that the forgoing description is illustrative only, and that various alternatives and modifications can be devised without departing from the spirit of the present invention. For example the profiled surfaces of the present invention may be provided on one or more mating surfaces of the present invention and the mating surfaces need not be linear or continuous, but may be non-linear and/or have as step changes or other discontinuities. Also, it is to be understood that the segments need not be cut or machined but may be provided in any suitable manner. The term "room temperature" is used in this application to refer to a non-operating temperature, such temperature being below a relevant operating temperature of the engine. Accordingly, the present application contemplates all such alternatives, modifications and variances.